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ABSTRACT

A quasi-experimental design was used in an investigation directed at determining whether laboratory time in microbiology would be more efficiently and effectively utilized if scheduled as semi-weekly sessions of 1.5 hours each rather than as a single 3-hour session. Efficiency was measured by the number of procedural and data errors made by students and the amount of time actually spent in lab. Learning outcomes, scores on an epidemic problem-solving assignment, and mean laboratory examination scores were used to denote effectiveness. Subjects consisted of two intact laboratory groups with 24 students in each group. Significant differences were noted between the two groups. Students in the semi-weekly section spend 18.3 percent more time in the laboratory, made 4.4 percent fewer procedural errors, 5.6 percent fewer data errors, and had 10.3 percent higher mean laboratory examination scores. However, no significant difference was noted for the epidemic problem set. It was recommended that serious consideration be given to offering additional microbiology laboratory sections on a semi-weekly basis as a method for improving management of the learning environment. It was also recommended that a similar study be conducted with students enrolled in anatomy. (Author/JN)

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TIME MANAGEMENT AND LABORATORY SCHEDULING AT A COMMUNITY COLLEGE

GOVERNANCE AND MANAGEMENT

by

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Glendale Cluster

A PRACTICUM PRESENTED TO NOVA UNIVERSITY
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DEGREE OF DOCTOR OF EDUCATION

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ABSTRACT

A quasi-experimental design was used in an investigation directed at determining whether laboratory time would be more efficiently and effectively utilized if scheduled as semiweekly sessions of one-and-a-half hours each rather than as a single three hour session. Efficiency was measured by the number of procedural and data errors made by the students and the amount of time actually spent in lab. Learning outcomes, scores on an epidemic problem solving assignment and mean lab exam scores, were used to denote effectiveness.

Students enrolled in General Microbiology at the College of the Sequoias participated in this study. Two intact lab groups, 24 students each, served as the population. One group met once a week for three hours and the other group met semiweekly for one-and-a-half hour sessions. Labs were monitored for a six week period and the following data were collected and evaluated using the Chi-square at $P < 0.05$: number of procedural errors and data errors, and the amount of time actually spent in lab. At the end of the semester, scores on the epidemic problem set and mean lab exam scores were evaluated with the t-test at $P < 0.05$.

Significant differences were noted between the two groups. The students in the semiweekly section spent 18.3% more time in lab, made 4.4% fewer procedural errors, 5.6% fewer data errors, and had 10.33% higher mean lab exam scores. However, no significant difference was noted for the epidemic problem set.

It was recommended that serious consideration be given to offering additional microbiology lab sections on a semiweekly basis as a method for improving management of the learning environment. It was also recommended that a similar study be conducted with students enrolled in anatomy.

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INTRODUCTION

California community college funding and control has been in a precarious position since the passage of California's Proposition 13 in 1978. The proposition accomplished its stated purpose which was to reduce property taxes. However, it also resulted in shifting the responsibility of community college funding and control from the local to the state level (Timar, 1982). Since that time funds have been scarce and community college education has become the subject of close scrutiny by the state. In 1982 the Legislature tied a list of over 300 courses, which could no longer be offered by the community college system, to the California Budget Act (The News, 1982).

Local administrators are surrounded by a complexity of problems. In an environment of scrutiny and financial scarcity, administrators must pay closer attention to the internal operations within their campuses. The main question being faced is how to obtain maximum benefit at minimum cost (Gonyea, 1981). More than ever, institutions will have to show that academic resources are effectively devoted to academic missions. Key academic resources include facilities, faculty, students, supplies, support staff, and time (Jedamus, 1981). These resources, among others, are directed towards achievement of the institutions's academic missions.

The purpose of this practicum was to examine several of these resources in an attempt to promote maximum efficiency and effectiveness in their utilization through a process of management. The

motive was to encourage efficient course management by the faculty themselves. The view taken was that management is a process (Sisk, 1973; Hersey and Blanchard, 1982), one that could be used by individual instructors to promote the best use of academic resources.

The current scheduling procedure for microbiology labs at College of the Sequoias specifies one three-hour lab period weekly. During that time frame, four to six experiments are often set-up. The following week, in addition to collecting data for the previous week's experiments, four to six new experiments are set-up. Several patterns have been noted while using this system. Many students are unorganized in their approaches to routine laboratory tasks; resulting errors often necessitate the use of duplicate supplies. Frequently, experimental data are inaccurately collected and recorded. And, many times, students leave lab early. In an attempt to promote more efficient and effective utilization of resources, this situation was approached as a management problem involving time and scheduling. Thus it has been suggested that a viable alternative to the three hour lab would be to divide the lab into two one-and-a-half hour segments per week.

Problem

The research problem investigated dealt specifically with time management and scheduling of microbiology labs at College of the Sequoias, Visalia, California. The question asked was, is weekly laboratory time utilized more efficiently and effectively if scheduled as a single three-hour block or if scheduled in two increments (semiweekly) of one-and-a-half hours each?

Hypothesis

The research hypothesis used in the development of this practicum was as follows. Weekly laboratory time would be more efficiently and effectively utilized by microbiology students if scheduled as semi-weekly sessions of one-and-a-half hours each rather than as a single three hour session.

Description Of The Study

Students enrolled in General Microbiology (Fall 1983) at College of the Sequoias participated in this study. A quasi-experimental design was followed in addressing the problem of determining whether there was a significant difference in efficient utilization of laboratory time and supplies between students attending a weekly lab and those attending semiweekly labs. Two intact lab groups, of 24 students each, constituted the population used in the experiment. One lab group met once a week for three hours. The other group met semiweekly for one-and-a-half hour sessions. The method of meeting (weekly or semiweekly) constituted the independent variable.

Labs were monitored for a six week period. Data for three dependent variables were obtained during that time: number of errors associated with setting-up experiments (procedural errors), number of errors associated with data collection (data errors), and amount of time actually spent in lab. At the end of the semester, data for two additional dependent variables were collected: scores from an epidemic problem, and scores from a comprehensive lab exam.

The data were analyzed using a series of null hypotheses at $P < 0.05$. The first three dependent variables were tested using Chi-square (X^2) while the last two were considered using the t-test.

BACKGROUND AND SIGNIFICANCE

Planning

In describing methods for improvement of academic programs, Pickering (1982:211) points out that,

> Massive amounts of money are not required to improve programs; what is needed is more careful planning and precise thinking about educational objectives.

It therefore becomes readily apparent that careful planning and management of resources has a key role both in improving as well as maintaining quality of educational endeavors.

Keele and Hayes (1982) have suggested that educators follow a management model as a tool of curriculum as well as course improvement. Their model includes: defining the problem and the change-goals, gathering data, summarizing and analyzing data, planning the action, implementation and evaluation. Wallhaus (1981:338) approaches the same process using a mathematical model of analysis. He explains that in considering program resource requirements and utilization,

> The purpose of analysis is to gain insights and not necessarily to resolve cosmic questions. For this reason, analyses of isolated and perhaps even peripheral aspects of a problem may well be made simply by learning more about the complexity of the problem. But having a solid conceptual understanding of the several dimensions of the problem will be increasingly important in order to avoid misinterpreting the results of separate and isolated analytical approaches.

Time

One important academic resource to consider is time. The concept of time and its relationship to various aspects of education has been receiving considerable attention. "Student time on task, teacher time on task, and administrator's management of time are areas being scrutinized critically" (McIntyre and Morris, 1982:422). According to Fitz-Gibbon and Clark (1982), studies on the use of time are important if only because time is a limited resource. Effective time management by academia can lead to more effective resource utilization and productivity (Regnier, 1981).

It has been predicted that 25% of each work day is wasted simply through poor scheduling of activities alone (Kvalseth, 1982). The Robert Half (1982) international time-theft studies, involving large corporations, estimate 2-40% of each week's company time is wasted via a variety of routes from arriving late or leaving early to general inattention to work. Studies such as these as well as those on the popular level, One Minute Manager (Blanchard and Johnson, 1982), The 59-Second Employee (Andre and Ward, 1984) or Elizabeth Forst's (1981) "The Successful Teacher's Guide To Time Management", all serve to emphasize the importance of this resource.

Mayer (1982) and Davenport (1982) point out the need to use available time in a positive manner in order to achieve personal satisfaction and maintain morale as well as to attain desired goals. To facilitate positive time utilization, Simon French at the University

of Manchester (1982) has developed a mathematical introduction to sequencing and scheduling of "job" activities. He provides analogies useful for the classroom laboratory in his treatment of general job-shop and flow-shop problems and Gantt diagrams.

To maximize their resources, some institutions have been experimenting with time management in terms of scheduling changes: a traditional one-hour M-W-F lecture format may be changed to three-hour time blocks, one-and-a-half blocks, or even to a Tu-Th-Sat format. In 1982 Noonan conducted a survey at Moraine Valley Community College to determine scheduling preferences for three hour lectures classes. Of 593 students and 55 faculty members surveyed, she found 55% of the students and 64% of the faculty preferred two one-and-a-half hour classes per week, 27% of the students and 23% of the faculty opted for a single three hour session while 18% and 13% respectively favored three one-hour sessions. In a similar study conducted at Harford Community College, MD, a majority of both students (N=280) and faculty (N=49) indicated a preference for one-and-a-half hour lecture classes (Murphy, 1982). Other scheduling innovations have suggested moving towards a four day week. Regardless of what other institutions have done, Regnier (1981) emphasizes that research should be performed in this area by each institution. Individual differences between disciplines at the same institution also need to be considered. As Forst (1981:33) puts it, "Time: everybody's resource - everybody's problem."

It is noted that the studies described above deal only with alternative scheduling patterns of lecture classes. A computer search

by the San Joaquin Valley Information Service and one by Nova University Informational Retrieval Service as well as a manual search failed to yield any reference of studies involving alternative scheduling models for laboratory sections.

Effectiveness And Efficiency

According to the literature (Forture, 1982; Pigors, et al., 1964; Steers, 1981), effectiveness may be defined as the extend to which operative goals can be attained. To maximize the possibility of attainment,

> Goals should be set high enough so that a person has to stretch to them but low enough so that they can be attained. Goals must be realistic before a person will make a real effort to achieve them (Hersey and Blanchard, 1982:23).

Efficiency is described as a cost/benefit ratio incurred in the pursuit of those goals. However, in the case of service industries (of which education is a part) these concepts are often difficult to quantify (Mark, 1982).

In general, research indicates that the more time one is able to devote to a certain task, the more effectively one is able to accomplish or perform that task (McIntyre and Morris, 1982; Fitz-Gibbon and Clark, 1982). However, regardless of the amount of time on task, ability remains a key factor (Dallam and Hoyt, 1981).

It is noted, however, that too much time on task can be detrimental in certain instances. Excess time on task has been associated with fatigue and stress (Steers, 1981). In the setting of business and industry, mental and physical fatigue have often been accompanied by higher accident rates (Martindale, 1977; Thygerson, 1977).

Excess time on task has also been studied in educational settings in the form of massed versus distributed learning studies. Bigge (1982:311) reports that

> Virtually all of the research evidence seems to show that distributed is more efficacious than massed practice. With massed practice, both fatigue and boredom reduce attention and tend to cause practice to deteriorate into mere repetition.

Bower and Hilgrad (1981) also note that fatigue is often associated with a loss in efficiency of learning performance. Mental fatigue serves as a inhibitory process of learning (Travers, 1977).

In general, distributed practice has a considerable advantage over massed practice. It takes less time to learn material if learning practice is distributed (Travers, 1977). And in some instances it has been found that distributed practice actually speeds up the learning process (Bigge, 1976).

Studies relating to the length of a learning period have failed to provide consistent results (Travers, 1977). Thompson and de Tornyay (1982:8) point out that "Frustration is common when too much information is given too rapidly or too soon to be absorbed by the learner." Additionally, Steers (1981) notes that if people feel that they are asked to do more than time or ability permits, they often experience a conflict between quantity and quality performance.

Significance Of The Study

This study was conducted for the purpose of improving lab course management at College of the Sequoias. The goal was to enhance the educational process. Since careful planning and management of

resources is considered to have a key role in quality education (Pickering, 1981), consideration was given to two resources at the College of the Sequoias, time and students.

PROCEDURE

Research Design

A quasi-experimental research design was used. It was similar to the control-group-posttest-only design described by Isaac and Michael (1977). Concepts from both management and learning were incorporated in this study. In order to approach the problem, the following steps were used. First, the population and the variables were identified. Next a sampling procedure was outlined and data were collected. Finally, the data were statistically analyzed and interpreted using a series of null hypothesis.

1. Population. All students registered for General Microbiology (Fall 1983) at College of the Sequoias constituted the population. This population consisted of two intact lab groups of 24 students each. Students in the 1-4 p.m. Wednesday lab section served as the control (weekly) group. The experimental (semiweekly) group were those students in the 1-2:30 p.m. Tuesday-Thursday lab section.
   In an attempt to establish that similar academic abilities existed within both lab groups, a comparison was made of their first lecture exam scores: control group $\overline{X}$ = 66.39, σ = 15.59; experimental group $\overline{X}$ = 65.63, σ = 17.99. Using the t-test, no significant difference was noted between the two groups.

II. Variables

A. Independent variable. The independent variable was the method of lab meeting, either weekly (control) or semi-weekly (experimental).

B. Dependent variables. Five dependent variables were used as measures of efficiency and effectiveness of laboratory scheduling.

1. procedural errors: errors associated with setting-up experiments (Appendix A).
2. data errors: errors associated with collection and/or recording of data (Appendix B).
3. actual in-lab time (Appendix C).
4. problem solving skills - epidemic problem scores (Appendix D).
5. comprehensive lab exam scores (Appendix E).

The first three variables were used to denote efficiency while the latter two were used to indicate effectiveness.

The matters of content validity, readability and reliability of the epidemic problem set and the lab exam were attended to by the methods described by Isaac and Michael (1977) and Wiersma (1980). Validity and readability were accounted for by the jury method with three colleagues. Reliability was checked using the Kuder-Richardson (KR-21) rational equivalence procedure (problem set, $r = 0.86$; lab exam, $r = 0.81$).

III. Sampling Procedure. The techniques used in the collection of data are outlined below.

1. Data related to the number of errors (procedural and data) and in-lab time were collected between the 7th and 12th weeks of the semester.
2. Each lab section was composed of six lab groups. All experiments were carried out as group projects due to the limitations of the facilities themselves.
3. Each lab group's operations were monitored. During each session, a check list of procedural errors was completed for the group. The total number of errors was computed for each group at the end of the six weeks. This data in turn was used to arrive at the total number of procedural errors for each lab section.
4. To determine the number of data errors, at the end of the six weeks, lab books were collected by group and reviewed. The average number of errors per group was calculated:

$$\frac{\text{total number of errors from all lab books in the group}}{\text{total number of lab books in the group}}$$

The average number of errors from each lab group in a lab section were then added together to arrive at a final total.

5. Actual time spent in lab was monitored for each meeting. The number of students present at the beginning of the meeting was determined by a sign-in sheet. The time at which 60% of those students had gone for the day was recorded along with the actual

time (in minutes) spent in lab. Data for the six week period were added together for the final calculations.

6. Data from the epidemic problem set was obtained at the end of the 15th week of the semester. The problem set was given as an individual assignment with a three hour time limit. The mean and standard deviation were determined for each lab section.
7. During the final week of the semester a comprehensive lab exam was given. The mean and standard deviation were determined for each lab section.

IV. Analysis of Data. The following null hypotheses were used in the analysis of the data ($P<0.05$). The first three hypotheses were tested using Chi-square (X^2) while the last two were considered using the t-test. All data were run on an Apple IIe computer using the Applesoft package Statistics With Daisy (K. C. Killion, 1981).

Ho1: There will not be a significant difference in the number of procedural errors made between students meeting for lab weekly compared to those meeting semiweekly.

Ha1: There will be a significant difference in the number of procedural errors made between students meeting for lab weekly compared to those meeting semiweekly.

Ho2: There will not be significant difference in the number of data errors made between students meeting for lab weekly compared to those meeting semiweekly.

Ha2: There will be a significant difference in the number of data errors made between students meeting for lab weekly compared to those meeting semiweekly.

Ho3: There will not be a significant difference in the amount of actual in-lab time between students meeting for lab weekly compared to those meeting semiweekly.

Ha3: There will be a significant difference in the amount of actual in-lab time between students meeting for lab weekly compared to those meeting semiweekly.

Ho4: There will not be a significant difference in mean scores for problem solving skills between students meeting for lab weekly compared to those meeting semiweekly.

Ha4: There will be a significant difference in mean scores for problem solving skills between students meeting for lab weekly compared to those meeting semiweekly.

Ho5: There will not a significant difference in the mean lab exam scores between students meeting for lab weekly compared to those meeting semiweekly.

Ha5: There will be a significant difference in the mean lab exam scores between students meeting for lab weekly compared to those meeting semiweekly.

Definition of Terms

To avoid the possibility of ambiguity, the following definitions were used in this study.

Student. Anyone enrolled in General Microbiology, Fall 1983, at

College of the Sequoias, Visalia, California. This consisted of one lecture section and two lab sections.

Weekly lab section. Students enrolled in the lab section meeting 1-4 p.m. Wednesday. This served as the control group.

Semiweekly lab section. Students enrolled in the 1-2:30 Tuesday-Thursday lab section. This constituted the experimental group.

Lab group. Working group composed of four students each. There were six working groups in each lab section.

Procedural errors associated with setting-up experiments: use of the wrong supplies (media, swabs, pipettes or cultures), incorrect labeling, incorrect storage of culture plates or improper disposal of contaminated supplies (Appendix A). Maximum number of possible errors per lab group = 251.

Data errors associated with data collection: mathematical units or descriptive information absent or incorrectly entered in lab workbook (Appendix B). Maximum number of possible data errors per lab group = 78.

In-lab time. The time interval, in minutes, that 60% of the students who were initially present at the beginning of a given lab period spent in lab (Appendix C). Maximum number of minutes = 900 (based on a 50-minute hour).

Session. Any lab meeting (period) either weekly or semiweekly.

Section. The weekly lab groups constituted one lab section. The semiweekly lab groups constituted another lab section.

Epidemic problem set. A set of questions related to a specific collection of data concerning an epidemic (Appendix D). It

was used to assess problem solving skills.

Lab exam. A comprehensive lab exam (Appendix E).

Efficient. Referred to in-put: supplies and/or time not unduly wasted.

Effective. Referred to out-put: learning outcome positive and a minimal amount of confusion (errors).

Assumptions And Limitations

Numerous assumptions and limitations were associated with this study. They are described below.

1. The students were not randomly selected. Two intact lab sections were used.
2. The sample size was small. Each section had 24 students.
3. It was assumed that the sample used was representative of the entire population of microbiology students at College of the Sequoias.
4. It was assumed that the students in the two sections had similar ranges of academic abilities and had similar levels of maturity. (See p. 9,I.)
5. The possibility of the Hawthorne and Halo Effects existed while monitoring for the number errors associated with both setting-up experiments and with data collection. (See p.11)
6. It was assumed that demographic data were not relevant to the results of this study.
7. The possible influence of outside pressures and obligations (family, financial, etc.) was ignored.
8. There was no control over factors of personality, motivation or stress.

RESULTS

The data presented in Table 1 were used for the testing of the first null hypothesis.

Ho1: There will not be a significant difference in the number of procedural errors made between students meeting for lab weekly compared to those meeting semiweekly.

The calculated value for X^2 was 10.769. This exceeded the critical value of 3.841 at $P < 0.05$. Hence, the null hypothesis was not accepted. The alternative hypothesis was accepted instead.

Ha1: There will be a significant difference in the number of procedural errors made between students meeting for lab weekly compared to those meeting semiweekly.

TABLE 1

Procedural Errors Associated With Setting-up Experiments

Group	Number of procedures			
	correct N	%	wrong N	%
Weekly	1233	81.9	273	18.1
Semiweekly	1299	86.3	207	13.7

Note: calculated $X^2 = 10.769$; X^2 at $P < 0.05$ (df 1) = 3.841

Table 2 contains data related to the second null hypothesis.

Ho2: There will not be a significant difference in the number of data errors made between students meeting for lab weekly compared to those meeting semiweekly.

Since the calculated X^2 value of 8.149 was greater than the critical value of 3.841 for $P < 0.05$, the second null hypothesis was also not accepted. The alternative hypothesis was therefore appropriate.

Ha2: There will be a significant difference in the number of data errors made between students meeting for lab weekly compared to those meeting semiweekly.

TABLE 2

Errors Associated With Data Collection

Group	Number of data entries			
	correct N	%	wrong N	%
Weekly	409	87.4	59	12.6
Semiweekly	435	93.0	33	7.0

Note: calculated $X^2 = 8.149$; X^2 at $P < 0.05$ (df 1) = 3.841

Data pertinent to null hypothesis number three are located in Table 3.

Ho3: There will not be a significant difference in the amount of actual in-lab time between students meeting for lab weekly compared to those meeting semiweekly.

The critical value of X^2 at $P < 0.05$ was exceeded. Thus, this null hypothesis failed to be accepted. The alternative hypothesis was then accepted.

Ha3: There will be a significant difference in the amount of actual in-lab time between students meeting for lab weekly compared to those meeting semiweekly.

TABLE 3

Actual Time Spent In Lab

Group	Number of minutes 60% of students present			
	in lab		left early	
	N	%	N	%
Weekly	620	68.9	280	31.1
Semiweekly	785	87.2	115	12.8

Note: calculated X^2 = 88.:4; X^2 at P< 0.05 (df 1) = 3.841

Statistics relevant to the fourth null hypothesis are located in Table 4.

Ho4: There will not be a significant difference in mean scores for problem solving skills between students meeting for lab weekly compared to those meeting semiweekly.

Since the critical value for t (1.960) at P< 0.05 was not exceeded, the null hypothesis was accepted.

TABLE 4

General Statistics For Epidemic Problem Set

Group	$\bar{X}$ (mean)	σ (standard deviation)	Range (0-20)
Weekly (N=24)	16.36	1.99	12-20
Semiweekly (N=24)	16.63	2.37	10-19

Note: calculated t = 0.477; critical t at $P<0.05$ (df46) = 1.960

Finally, the statistical data used in the analysis of the last null hypothesis are given in Table 5.

Ho5: There will not be a significant difference in the mean lab exam scores between students meeting for lab weekly compared to those meeting semiweekly.

The value calculated for t was noted to exceed the critical value. Accordingly, the fifth null hypothesis was not accepted. The alternative hypothesis was accepted in its place.

Ha5: There will be a significant difference in the mean lab exam scores between students meeting for lab weekly compared to those meeting semiweekly.

TABLE 5

General Statistics For Lab Exam

Group	$\bar{X}$ (mean)	σ (standard deviation)	Range (0-100)
Weekly (N=24)	61.50	11.59	28-83
Semiweekly (N=24)	71.83	11.17	52-85

Note: calculated t = 3.145; critical t at $P < 0.05$ $(df46) = 1.960$

DISCUSSION

The research question under investigation dealt with scheduling of weekly laboratory time for microbiology students at College of the Sequoias. The hypothesis which guided the development of this investigation was that laboratory time would be more efficiently and effectively utilized by students if scheduled as semiweekly sessions of one-and-a-half hours each, rather than as a single three hour session. This hypothesis has been supported by the data presented in Tables 1-5 and in the testing of a series of null hypotheses.

To summarize, efficiency was measured by the number of procedural and data errors made by the students and the amount of time actually spent in lab. Learning outcomes, scores on the epidemic problem solving assignment and mean lab exam scores, were used to denote effectiveness.

Procedural as well as data errors were made by students in both

sections. This was not unexpected since the learning process is associated with a certain amount of "trial-and-error" even when specific instructions have been provided (Kron, 1981). However, it was noted that students in the semiweekly section made significantly fewer errors as indicated by the results from the Chi-square test (Table 1 and 2).

When comparing the amount of actual in-lab time (Table 3), it can be seen that many students in both sections left lab early. Using the Chi-square test, it was noted that the semiweekly students spent significantly more of the assigned time in lab (87.2% compared to 68.9%). Thus in describing the efficiency of performance between students in the semiweekly lab section compared to students in the weekly lab section, three points can be noted. Students in the semiweekly section:

1. spent 18.3% more time in lab
2. made 4.4% fewer procedural errors
3. made 5.6% less data errors

Therefore, it has been concluded that in terms of over-all student efficiency, a semiweekly lab schedule is more satisfactory than a single weekly lab section.

Results of effectiveness, as measured by learning outcome, have been recorded in Tables 4 and 5. No significant difference (t-test) was found in problem solving skills between students in the two groups (Table 4). However, there was a significant difference (t-test) in mean lab exam scores (Table 5). The mean score was 10.33% higher (71.83 vs 61.50) for students in the semiweekly group while the standard deviation only differed by 0.42 (11.17 vs 11.59).

Based upon this data, it was concluded that semiweekly lab scheduling was more effective than single weekly scheduling. The foregoing conclusions are consistent with Travers (1977:288) recommendation that "school work should be divided into short sessions covering particular areas of content."

As a final point of interest, actual time on task remains an important issue. More time on task was associated with greater efficiency in setting-up experiments, collection of data, as well as with greater learning effectiveness. This observation is consistent with Bugelski's Total Time Hypothesis (Travers, 1977) which holds that the most important condition of learning is the total amount of time devoted to the task. The massed time assignment (single three hour block) was less utilized than the distributed time assignment (two one-and-a-half hour blocks).

Recommendations

Following the principle of Ockam's Razor than "entities must not be multiplied beyond what is necessary" (Courtenay, 1977:260), two recommendations have been made. First, serious consideration should be given to offering additional microbiology lab sections on a semiweekly basis as a method for improving management of the learning environment. It is also recommended that a study similar to this one be conducted with students enrolled in anatomy.

In addition to these recommendations, it is suggested that two new studies be developed: one which considers reasons for performance differences and one which examines scheduling preferences among students and faculty.

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APPENDIX A

DATE: _____

LAB SECTION: _____

PROCEDURAL ERROR DATA SHEET

LAB GROUP: _____

EXPERIMENT: _____

Number incorrect		Number correct
_____	media used	_____
_____	swab used	_____
_____	pipettes used	_____
_____	cultures used	_____
_____	storage of plates	_____
_____	labeling	_____
_____	disposal of contaminated supplies	_____
_____	TOTALS	_____

APPENDIX B

DATE: _____

LAB SECTION: _____

DATA ERROR/NOTEBOOK SHEET

LAB GROUP: _____

EXPERIMENT: _____

Number incorrect or absent		Number correct
_____	mathematical units	_____
_____	descriptive data	_____
_____	TOTALS	_____

APPENDIX C

LAB SIGN-IN SHEET

DATE:_____

LAB SECTION:_____

NAME

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____
11. _____
12. _____
13. _____
14. _____
15. _____
16. _____
17. _____
18. _____
19. _____
20. _____
21. _____
22. _____
23. _____
24. _____

FOLD HERE WHILE STUDENTS SIGN FOR THE LAB PERIOD

Time lab started:_____

Time 60% students left lab early:_____

Total minutes 60% students in lab:_____

Total minutes 60% students left early:_____

APPENDIX D

CASE HISTORY

An Epidemic of Food Poisoning (The Problem)

Background: An outbreak of food poisoning occurred the last week of June affecting two thirds of the 1700 persons from a 4-parish area who attended a dinner at Port Allen, Louisiana.

A questionnaire survey to obtain information concerning the illness was administered to a sample of 122 people. Of this sample, 82 (67.2%) reported illness. Physicians were seen for treatment of 32 patients (26.2%) and 9 (7.4%) required hospitalization.

Laboratory analysis yielded positive cultures of the etiological agents from the leftover boiled shrimp, boiled corn and hogshead cheese and from 7 of 15 stool samples from patients. The person who collected the leftover food for storage placed all of it in one container.

Potatoes were purchased from a farmer. They had been stored in a root cellar and were transported loose in a pick-up truck. The potatoes were washed, peeled and boiled until done. The potatoes were boiled the morning of the dinner. The pots were covered with aluminum foil to keep the contents warm and transported unrefrigerated 40 miles to the dinner.

The corn was purchased from a produce market. The night before the dinner the corn was shucked and kept in the wooden boxes in which it had been purchased. The day of the dinner the corn was boiled. For transport the corn was wrapped in aluminum foil.

The hogshead cheese was purchased the morning of the dinner along with the salt meat. The headcheese and salt meat were kept refrigerated by the delicatessen. After purchase they were stored unrefrigerated until dinner. Read labels in the deli-section of your grocery store to ascertain the ingredients in headcheese.

The raw shrimp was purchased at one location and shipped to a second location in standard, wooden seafood boxes. It was boiled on the morning of the dinner and placed back into the same boxes. After being covered with aluminum foil to keep the contents warm it was transported 40 miles in an unrefrigerated truck to the dinner. An inspection of the wholesale seafood establishment was undertaken 6 days later. The investigation revealed the shrimp had been boiled in 300-lb batches in the following manner. A batch was placed in a container until the water came to a "rolling boil." At that time the gas was turned off and the shrimp allowed to soak in the hot water for 15 minutes.

(Data from Tortora, Funke, and Case, 1982.)

Case #	Age	Sex	Symptoms*								Ate**							Onset		Duration (Days)
			D	C	W	N	C	H	F	V	1	2	3	4	5	6	7	Day	Hour	
1	13	F	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	S	11p	1
2	21	F	+	+	+	+	+	+	+	+	+		+			+	+	M	12n	4
3	64	F	+	+	+	+	+		+		+	+	+	+	+	+	+	M	1p	3
4	32	M	+	+	+	+	+	+	+	+	+	+	+	+	+		+	M	5p	2
5	41	F	+	+	+	+	+	+		+	+	+	+		+		+	T	8a	4
6	42	M	+	+	+	+	+	+	+	+	+	+	+	+	+		+	M	8a	6
7	30	M	+	+	+	+					+		+	+		+	+	S	12m	7
8	50	M						+					-	+		+	+	W	8a	
9	55	M	+	+	+	+		+	+		+	+	+		+		+	S	11p	1
10	60	F	+								+	+	+	+	+		+	T	7p	3
11	61	M	+		+		+	+	+		+	+	+	+	+		+	M	12n	4
12	19	M	+	+			+	+	+		+		+			+	+	S	10p	4
13	22	F											+	+		+	+			
14	70	F	+	+	+		+	+	+		+	+	+	+	+		+	M	1p	6
15	69	F	+	+	+		+	+	+		+	+	+	+	+		+	M	9a	6
16	68	M	+	+	+		+					+	+	+	+	+	+	M	12n	5
17	34	F	+	+	+		+				+	+	+		+		+	M	1p	5
18	40	F			+	+	+					+	+		+	+	+	M	pm	7
19	41	F	+	+	+	+	+	+	+	+	+	+		+	+	+	+	S	pm	5
20	59	M										+			+	+	+			
21	78	M	+	+	+	+	+	+	+		+			+		+	+	T	am	5
22	73	F	+	+	+		+				+		+	+			+	M	5p	4
23	46	F	+	+	+		+				+		+		+			M	4a	3
24	57	M	+	+	+						+	+	+	+	+		+	M	9a	2
25	34	M	+	+	+	+					+		+			+	+	M	9p	8
26	72	M	+	+	+						+		+	+		+		T	1a	8+
27	32	M	+	+	+	+	+	+	+	+	+		+				+	T	am	7
28	61	F	+	+	+	+	+	+	+	+	+		+		+			S	12m	1
29	36	F	+	+	+	+	+	+	+	+	+		+	+		+		M	1a	2
30	59	M	+	+	+	+	+	+	+		+		+		+		+	M	pm	2
31	74	M	+	+	+	+	+	+	+		+		+		+		+	M	10a	4
32	50	M										+	+	+		+	+			
33	54	M	+	+		+						+	+		+	+	+	M	am	5
34	?	M	+	+	+	+					+		+	+		+		T	am	6
35	39	M	+	+	+	+					+	+	+		+		+	S	pm	8+
36	40	M	+	+	+	+		+			+		+	+		+		M	10a	1
37	78	F	+	+	+	+						+	+	+	+		+	M	9a	8+
38	57	F	+		+	+						+	+	+		+	+	M	8a	7
39	14	M	+		+	+						+	+		+	+	+	M	pm	4
40	15	M		+	+	+						+	+		+	+		M	10a	2
41	60	F	+	+	+	+	+	+	+		+		+	+		+	+	M	11a	4
42	63	M	+	+	+	+	+	+	+		+		+		+	+		S	11p	5
43	81	F	+	+	+	+	+	+	+		+		+	+	+	+	+	T	11a	6
44	57	F	+	+	+	+	+	+	+		+		+			+	+	T	12n	7
45	32	M	+	+	+	+	+	+	+		+		+	+				M	12n	6
46	?	F	+	+	+	+	+	+	+		+			+	+	+	+	M	8a	7
47	20	F	+	+	+	+	+	+	+		+			+	+		+	M	9a	2
48	25	M	+	+	+	+						+				+		S	10p	2
49	32	F	+	+	+	+					+	+		+		+	+	S	12n	3
50	38	M	+	+	+	+					+	+			+	+		M	10a	4
51	40	F	+	+	+	+					+	+	+	+		+	+	M	12n	5
52	45	M	+	+	+	+					+		+		+		+	T	12n	5
53	18	F	+	+	+	+					+		+	+		+	+	M	12n	3
54	10	M	+	+	+	+	+	+	+		+		+	+	+	+	+	M	11a	2
55	20	F	+	+	+	+	+	+	+		+		+	+				T	1a	2
56	60	F	+	+	+	+	+	+	+		+		+		+	+	+	M	11a	3

BEST COPY AVAILABLE

Case #	Age	Sex	Symptoms*								Ate**							Onset		Duration (Days)
			D	C	W	N	C	H	F	V	1	2	3	4	5	6	7	Day	Hour	
57	63	M	+	+	+	+						+			+	+	+	T	11a	4
58	57	M	+	+	+							+		+		+		S	pm	4
59	46	F										+		+	+		+			
60	45	M	+	+	+							+		+		+	+	M	am	3
61	60	M	+	+	+		+	+	+			+	+		+	+	+	M	8a	1
62	14	M	+	+	+							+	+		+	+	+	M	6p	5
63	39	M	+	+	+									+	+	+	+	M	5a	3
64	48	M	+	+	+							+	+		+	+	+	T	1a	2
65	33	F	+	+	+	+	+	+	+	+		+	+	+		+	+	S	11p	3
66	50	F	+	+	+							+	+	+		+	+	M	3p	7
67	17	F	+	+	+	+	+	+	+	+		+	+	+	+	+		M	2a	3
68	59	M	+	+	+	+	+	+	+	+		+		+		+		M	11a	5
69	46	F	+	+	+	+	+	+	+	+		+		+	+	+	+	S	10p	6
70	34	F	+	+	+							+		+	+	+		T	3a	1
71	35	M	+	+	+							+		+		+		T	4a	2
72	50	F	+	+	+								+	+		+	+	M	9a	8
73	56	M	+	+	+	+						+		+				M	9p	8
74	45	M	+	+	+	+						+		+		+		M	1a	5
75	?	F	+	+	+	+	+	+	+	+		+						T	2a	7
76	63	M	+	+	+	+	+	+	+	+		+				+	+	S	12m	3
77	54	F	+	+	+								+	+		+		S	11p	4
78	35	F	+	+	+	+	+	+	+			+		+		+		M	12n	4
79	38	M	+	+	+	+	+	+	+			+			+		+	M	4a	5
80	33	M											+	+		+				
81	32	F										+	+		+		+			
82	47	F	+	+	+	+	+	+	+			+		+	+		+	M	4a	7
83	49	M						+				+		+		+		S	9p	
84	38	F	+	+	+	+	+	+	+			+		+	+		+	M	3p	1
85	42	F	+	+	+	+	+	+	+			+	+			+		M	5a	5
86	45	M	+	+	+	+	+	+	+			+			+		+	M	2a	5
87	49	M	+	+	+	+	+	+	+			+			+	+	+	T	3a	6
88	71	F	+	+	+	+	+	+	+	+		+				+	+	M	10a	3
89	75	F	+	+	+	+	+	+	+			+				+		M	2p	8
90	39	M	+	+	+	+	+	+	+			+			+		+	S	11p	2
91	70	F	+	+	+										+	+	+	M	5a	4
92	48	F	+	+	+	+	+	+	+			+			+		+	M	6p	6
93	21	F	+	+		+						+	+		+	+		M	2a	5
94	24	F	+			+						+	+	+	+	+	+	M	11p	7
95	25	M	+		+	+						+				+		M	9a	5
96	40	M	+	+	+	+	+	+				+	+		+		+	M	8a	2
97	36	F	+	+	+							+					+	T	2a	4
98	58	M	+	+	+							+	+	+	+	+	+	S	10p	1
99	?	F	+	+	+	+	+	+	+			+	+		+		+	T	1a	7
100	41	F	+	+	+	+	+	+	+			+	+	+	+		+	M	3p	5
101	55	F	+	+	+	+	+	+	+			+	+	+		+		S	9p	3
102	42	M	+	+	+	+	+	+	+			+	+	+		+	+	T	2p	4
103	27	M	+	+	+	+	+	+	+			+		+	+		+	M	3a	3
104	25	F	+	+	+	+	+	+	+			+		+			+	M	11a	6
105	20	M											+		+	+	+			
106	18	F										+		+		+				
107	45	M	+	+	+	+							+		+		+	M	2a	5
108	33	F	+	+								+		+	+	+		M	5p	6
109	65	M										+		+			+			
110	14	F	+	+	+	+	+	+	+			+	+			+	+	M	6a	1
111	15	M	+	+	+	+							+		+	+		M	3p	7
112	50	F	+	+	+	+	+	+	+			+	+	+	+		+	S	11p	7

BEST COPY AVAILABLE

Case #	Age	Sex	Symptoms*								Ate**							Onset		Duration (Days)
			D	C	W	N	C	H	F	V	1	2	3	4	5	6	7	Day	Hour	
113	?	F	+	+	+	+							+		+		+	M	2a	5
114	12	F	+	+	+	+	+	+	+		+			+		+	+	T	3a	4
115	18	M	+	+	+	+							+	+	+			S	10p	6
116	70	M	+	+	+	+	+	+	+	+	+			+		+		T	1a	3
117	33	M	+	+	+	+							+		+	+		M	11p	2
118	60	F	+	+	+	+	+				+	+	+			+	+	M	6a	5
119	50	M	+	+	+	+	+				+			+			+	T	2a	5
120	48	F	+	+	+	+	+		+		+				+	+	+	M	3p	7
121	13	F	+	+	+	+	+									+		M	4a	4
122	19	F	+	+	+	+	+		+		+	+		+		+	+	S	10p	6

* D = Diarrhea
C = Cramps
W = Weakness
N = Nausea
C = Chills
H = Headache
F = Fever
V = Vomiting

** 1 = Boiled shrimp
2 = Head cheese
3 = Boiled potatoes
4 = Boiled corn
5 = Boiled salt meat
6 = Bread/butter
7 = Watermelon

Dinner @ 6 p.m. Sunday

BEST COPY AVAILABLE

NAME _____

DUE _____

FOOD POISONING EPIDEMIC

1. Complete a summary of data for the epidemic.

   average duration: _____

   average onset period: _____

   average age group most effected: _____

2. Vibrio parahaemolyticus was found to be the causal agent in this epidemic. Based upon the information given, what evidence would rule out each of the following types of food poisoning?

   shigellosis:

   salmonellosis:

   botulism:

   gastroenteritis (Clostridium perfringens):

3. Assume you are "problem solving" using the scientific method. You need to determine the source of contamination.

   State a general hypothesis.

   State a null hypothesis and a corresponding alternative hypothesis.

4. What information would you need in order to either support or reject the H_0 stated above?

5. What food item was originally contaminated?

6. How did the other food items get contaminated?

7. Suggest three means which would have prevented this particular epidemic.

8. Would either Rivers' or Koch's postulates be suitable for sovling the epidemic problem at hand? Why?

9. Define the following terms.

   food infection:

   food intoxication:

10. What is the difference between a food infection and food intoxication?

11. Given two examples of each.

    food infection:

    food intoxication:

12. Which would be more life threatening, a problem involving food infection or food intoxication? Explain.

APPENDIX E

NAME _____

MICROBIOLOGY EXAM

1. The diameter of a field thru a scanning lens using a binocular microscope with 10x oculars is _____.

2. Maximum number of bacteria that could be present in a glass of water without being noticed when being served is _____.

3. Draw the following items to scale. (Give approximate sizes and show your scale.) RBC, bacillus, yeast, protozoan (The same scale must be used for all organisms.)

4. What is a bacterial pellicle?

5. What anatomical structure is involved in a bacterial pellicle?

6. What is the difference between a parasite and a saprophyte? Include an example of each.

7. Common name for Saccharomyces: _____

8. Diagram and name the shape of the cow peas yellows virus.

9. Are culture plates usually incubated upside down or right side up?

10. Usual temperature for incubation of petri plates is _____.

11. Determine the titer using the following data:
    a. 1 ml sample added to 199 ml of water
    b. 0.8 ml plated
    c. 168 colonies per plate

    titer = _____

12. 0.1% citric acid solution has a fair buffer system. True or false?

13. Phenophthalein causes the pH to change. True or false?

14. Are household cleaners disinfectants? _____

15. Explain your answer to question 14.

16. Name one antiseptic:_____

17. Describe the mode of action of the antiseptic named above.

18. Give an example of both a stated claim as well as an implied claim associated with Listerine.

19. How is Giardia transmitted?

20. Common name for Enterbius vermicularis:_____

21. Recommended control for the organisms named in question 20.

22-26. General information related to the hepatitis epidemic.

22. Infectious agent:_____

23. Reservior:_____

24. Period of communicability:_____

25. Graph to demonstrate each of the following conditions:

    a. person to person spread
    b. common source spread
    c. spread which in involved in this epidemic

a. b. c.

26. Why does one calculate the rate of the infection in terms of cases per 1,000 or 10,000?

27. How is Strep. mutans related to oral microbiology?

28. Name two methods used to determine the size of viruses.

****

Refer to the specimens located on the back lab table.

29. Could this be the causal agent for lockjaw? _____

30. Rationale for your answer to question 29.

31. Name causal agent of lockjaw:_____

32. Name two control measrues for lockjaw.

33. Which of the three sprecimens could be the causal agent of trichinosis? _____

34. What is the major source of trichinosis in the U.S.?

35. Is this a bacterium or a fungus? _____

36. What criteria did you used to answer question 35?

37. Does this represent a culture of microorganisms? _____

38. Expalin reason for your answer to question 37.

39. Common name of vector shown: _____

40. Is this a biological or mechanical vector? _____

41. Type of organism shown:

42. Explain how and why this organism is of significance to man.